U.S. DEPARTMENT OF COMMERCE
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PB-271 483

Banks Lake, Grant and Douglas Counties Washington

National Eutrophication Survey, Las Vegas, Nev

Prepared for
Environmental Monitoring and Support Lab, Las Vegas, Nev

Jul 77

PB 271 483

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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NATIONAL TECHNICAL
INFORMATION SERVICE

Report
on
Banks Lake
Grant and Douglas Counties
Washington
EPA Region X
Working Paper No. 865

With the cooperation of the
Washington Department of Ecology
and the
Washington National Guard
July, 1977

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.	2. RECIPIENT'S ACCESSION NO. PB-271 488
4. TITLE AND SUBTITLE: Report on Banks Lake, Grant and Douglas Counties, Washington	5. REPORT DATE: Prepared July 1977
7. AUTHOR(S): Anonymous (National Eutrophication Survey Staff)	8. PERFORMING ORGANIZATION REPORT NO. Working Paper No. 865
9. PERFORMING ORGANIZATION NAME AND ADDRESS: National Eutrophication Survey, U.S. Environmental Protection Agency, P.O. Box 15027, Las Vegas, NV 89114	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Office of Research and Development, U.S. Environmental Protection Agency, 401 M Street, S. W., Washington, DC 20460	13. TYPE OF REPORT AND PERIOD COVERED: Final - 1975
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES: Prepared in cooperation with the U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Eutrophication Survey Branch, Corvallis, OR 97330

16. ABSTRACT:

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 08C

18. DISTRIBUTION STATEMENT: Release unlimited	19. SECURITY CLASS (This Report)	21. NO. OF PAGES 42
	20. SECURITY CLASS (This page)	22. PRICE

EPA Form 2220-1 (9-73)

REPORT ON BANKS LAKE

GRANT AND DOUGLAS COUNTIES, WASHINGTON

EPA REGION X

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 865

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

July 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §306(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Washington Department of Ecology for professional involvement, to the Washington National Guard for conducting the tributary sampling phase of the Survey, and to those Washington wastewater treatment plant operators who provided effluent samples and flow data.

Mr. Barbara Blau, Lake Restoration Program, and the staff of the Washington Department of Ecology, Lake Restoration Program, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

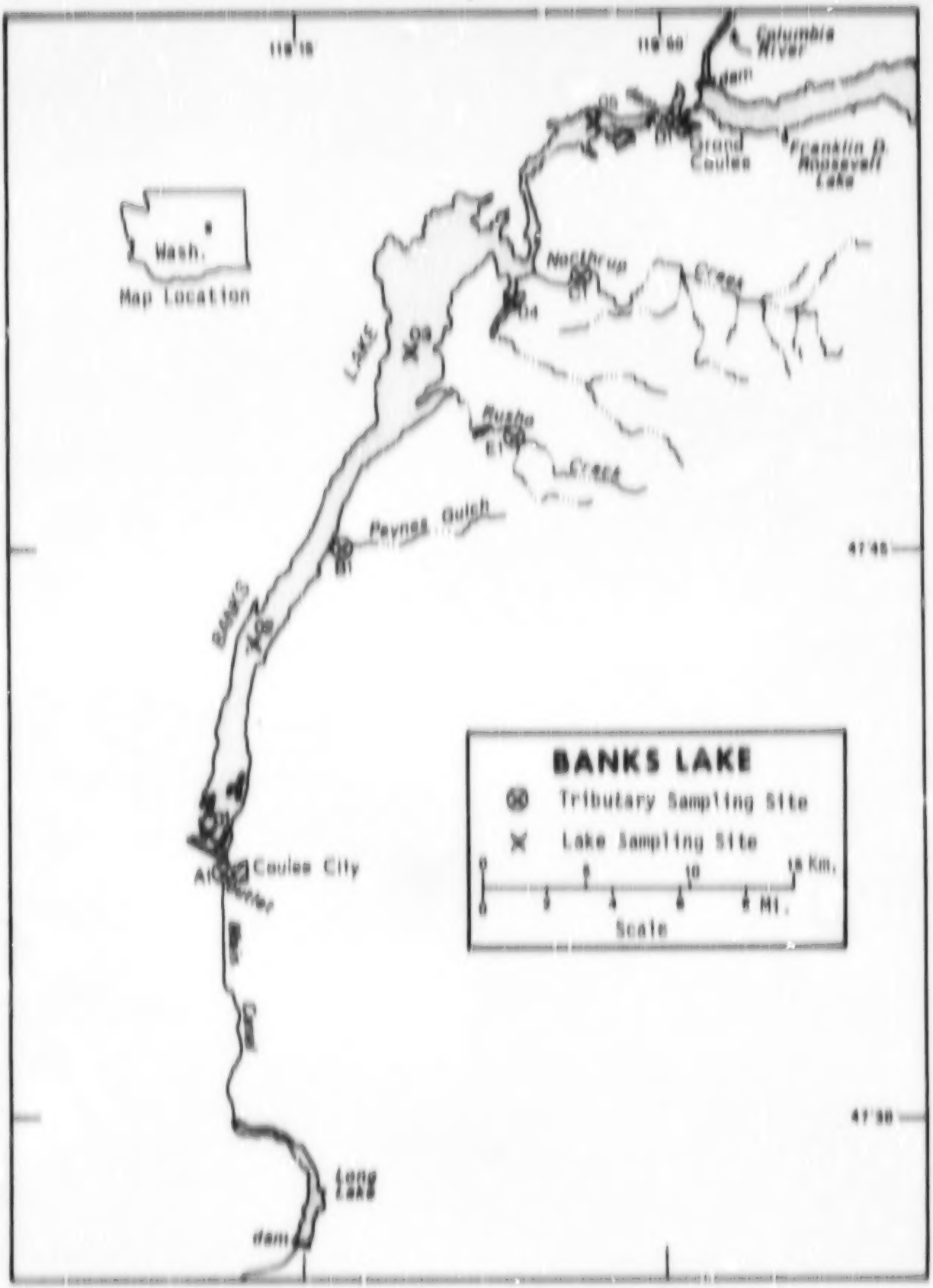
Major General Howard S. McGee, Adjutant General of Washington, and Project Officer Colonel Clinton C. Johnson, who directed the volunteer efforts of the Washington National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WASHINGTON

LAKE NAME	COUNTY
American Lake	Pierce
Banks Lake	Grant, Douglas
Chelan Lake	Chelan
Diamond Lake	Pend Oreille
Green Lake	King
Keechelus Lake	Kittitas
Mayfield Lake	Lewis
Medical Lake	Spokane
Moses Lake	Grant
Ozette Lake	Clallam
Sammamish Lake	King
Lake Whatcom	Whatcom
Lower Granite Reservoir	Garfield, Whatcom


Wash.
Map Location
Columbia River
dam
Grand Coulee
Franklin D Roosevelt Lake
Northrup Creek
Lake
Russo Creek
Peyton Gulch
Banks
Coulee City
Long Lake
dam
47°45
47°30
BANKS LAKE
Tributary Sampling Site
Lake Sampling Site
0
5
10
15 Km.
0
4
8 Mi.
Scale

REPORT ON BANKS LAKE, WASHINGTON

STORET NO. 5302

I. INTRODUCTION

Banks Lake was included in the National Eutrophication Survey as a water body of interest to the Washington Department of Ecology. A number of streams to Banks Lake were sampled; however, normalized flow data for these tributaries were not available so annual nutrient loadings to the lake could not be calculated. The tributary sampling data are included in Appendix D for the record, and are summarized in Section V of the report.

Banks Lake was created in 1951 and is primarily fed by water pumped from Franklin D. Roosevelt Reservoir through Feeder Canal (D-1) during the driest months of the year. The lake receives heavy recreational and irrigation use (Dion, et al., 1976).

II. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate that Banks Lake is mesotrophic. Chlorophyll a values ranged from a low of 2.0 µg/l to a high of 27.2 µg/l, with a mean of 7.4 µg/l. Potentials for primary productivity as measured by algal assay control yields were moderate to low. Of the 13 Washington lakes sampled in 1975, 5 had greater median total phosphorus values (0.021 mg/l).

*See Appendix I.

12 had higher inorganic nitrogen levels (0.040 mg/l) and 8 had higher median dissolved orthophosphorus levels (0.007 mg/l) than Banks Lake.

Survey limnologists did not report any problem algal blooms during their visits to the lake.

C. Rate-Limiting Nutrie .

Algal assay results indicate that Banks Lake was limited by available phosphorus levels on the sample collection dates (04/03/75, 09/10/75). Lake data suggest primary limitation by nitrogen.

III. LAKE CHARACTERISTICS

A. Lake Morphometry:*

1. Surface area: 100.77 km^2.
2. Mean depth: 12.4 meters.
3. Maximum depth: 25.9 meters.
4. Volume: 1251.006 x 10^6 m^3.
5. Mean hydraulic retention time: 175 days.

B. Precipitation:

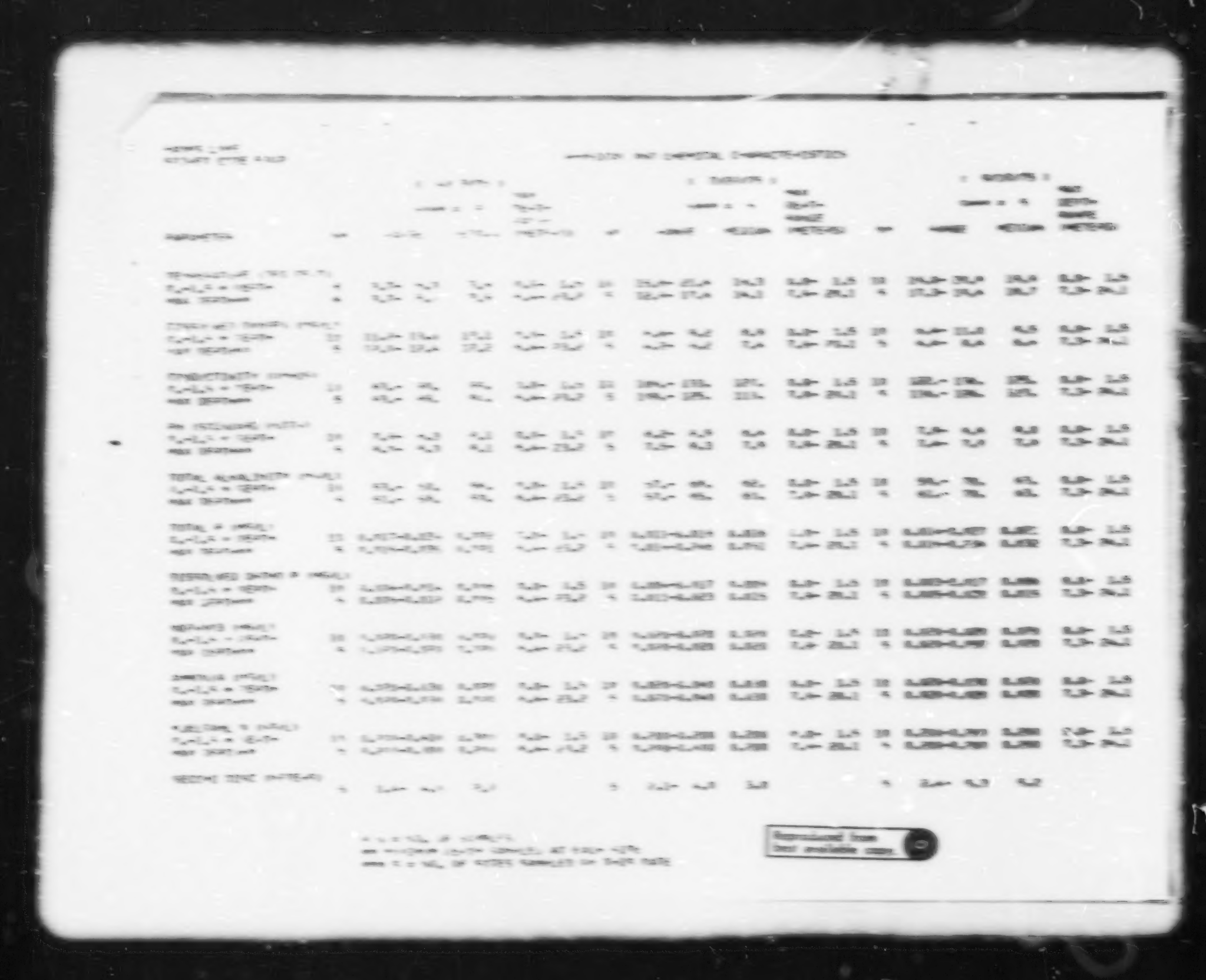
1. Year of sampling: 32.6 cm.
2. Mean annual: 32.2 cm.

*E.E. Wolcott, 1965. Hydraulic retention time calculated by dividing the lake volume by provided mean flow of the outlet.

IV. LAKE WATER QUALITY SUMMARY

Banks Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from five stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 11.3 meters at Station 01, 24.1 meters at Station 02, 18.9 meters at Station 03, 11.6 meters at Station 04, and 20.1 meters at Station 05. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.



B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/03/75	1. Asterionella	3,434
	2. Tabellaria	350
	3. Lyngbya	167
	4. Dinobryon	119
	5. Chroomonas	98
	Other genera	168
	Total	3,942
07/22/75	1. Melosira	690
	2. Asterionella	240
	3. Anabaena	221
	4. Ankistrodesmus	55
	5. Chroomonas	55
	Other genera	111
	Total	1,380
09/10/75	1. Asterionella	624
	2. Tabellaria	451
	3. Fragilaria	416
	4. Chroomonas	241
	5. Aphanizomenon	173
	Other genera	148
	Total	2,255

8. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
04/03/75	01	4.8
	02	27.2
	03	12.6
	04	12.8
	05	12.9
07/22/75	01	2.2
	02	3.0
	03	2.0
	04	5.5
	05	2.2
09/10/75	01	2.3
	02	2.9
	03	2.8
	04	11.6
	05	6.8

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
a. 04/03/75	Stations 01, 02		
Control	<0.008	0.024	0.2
0.05 P	<0.058	0.024	0.9
0.05 P + 1.0 N	<0.058	1.024	15.0
1.00 N	<0.008	1.024	0.2
	Stations 03-05		
Control	0.003	0.022	0.2
0.05 P	0.053	0.022	1.2
0.05 P + 1.0 N	0.053	1.022	23.7
1.00 N	0.003	1.022	0.3
b. 09/10/75	Stations 01,02		
Control	0.010	0.030	0.4
0.05 P	0.060	0.030	1.8
0.05 P + 1.0 N	0.060	1.030	11.8
1.00 N	0.010	1.030	0.3
	Stations 03-05		
Control	0.010	0.020	0.2
0.05 P	0.060	0.020	3.4
0.05 P + 1.0 N	0.060	1.020	20.3
1.00 N	0.010	1.020	0.6

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary productivity of Banks Lake was low during the spring sampling (04/03/75) and moderate during the fall sampling (09/10/75). In all assays, a significant increase in yield over that of the control occurred when phosphorus was added alone, indicating phosphorus limitation. Spikes with nitrogen and phosphorus simultaneously resulted in maximum yield. Additions of nitrogen alone did not stimulate growth significantly beyond the control yields.

The mean inorganic nitrogen to orthophosphorus ratios (N/P) in the lake samples were approximately 6/1, 4/1, and 5/1 in the spring, summer, and fall, respectively, suggesting nitrogen limitation (an N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

V. MEAN NUTRIENT CONCENTRATIONS IN UNGAGED STREAMS

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
B-1 Paynes Gulch	0.259	5.734
C-1 Northrup Creek	0.196	2.219
D-1 Feeder Canal	0.039	0.465
E-1 Rusho Creek	1.120	0.019
F-1 Unnamed Stream*	0.460	7.937

*This stream was sampled as a special interest tributary and lies outside the watershed of Banks Lake.

VI. LITERATURE REVIEWED

Dion, N.P., G.C. Bortleson, J.B. McConnell and L.M. Nelson. 1976. Reconnaissance Data on Lakes in Washington, Volume 6. Washington Department of Ecology, Water Supply Bulletin 43, Volume 6.

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Walcott, E.E. 1965. Lakes of Washington, Volume II. Washington Division of Water Resources, Water Supply Bulletin, 14 and 15.

VII. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

APPENDIX C

PHYSICAL AND CHEMICAL DATA

[illegible]

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

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APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF WASHINGTON

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of Washington lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in ug/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 16 to create table entries.

LAKE DATA TO BE USED IN RANKING

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG N	[illegible] AVG SEC	[illegible] CHLORA	[illegible] AVG SD	[illegible] SUM TYLO P
5301	[illegible] LAKE	0.127	0.195	343.000	4.827	15.707	0.007
5302	[illegible] LAKE	0.121	0.340	384.533	7.373	18.000	0.007
5303	[illegible] LAKE	0.105	0.370	111.000	8.105	6.450	0.023
5304	[illegible] LAKE	0.014	0.360	303.467	14.537	14.250	0.010
5305	[illegible] LAKE	0.027	0.150	415.000	2.903	18.667	0.009
5306	[illegible] LAKE	0.007	0.340	280.250	1.480	8.200	0.007
5307	[illegible] LAKE	0.014	0.170	402.000	4.256	18.400	0.007
5308	[illegible] LAKE	0.175	0.225	471.714	18.425	15.000	0.144
5309	[illegible] LAKE	0.115	0.140	403.600	28.040	24.670	0.030
5310	[illegible] LAKE	0.018	0.110	403.333	1.205	7.250	0.000
5311	[illegible] LAKE	0.015	0.210	374.000	7.200	14.600	0.004
5312	[illegible] LAKE	0.004	0.320	200.000	3.420	18.400	0.006
5313	[illegible]	0.033	0.150	475.500	4.875	7.200	0.022